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THE INFLUENCE OF PLANNED PHYSICAL ACTIVITY
IN PRESCHOOLERS ON SUBSEQUENT
ENERGY BALANCE

BY
CHELSEY LEIGH DA SILVA

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
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IN
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2016

MASTER OF SCIENCE THESIS

OF

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ABSTRACT

Background: Obesity is a chronic disease and is defined as having excess fat.

However, it is unknown if the caloric expenditure of planned physical activity in children will be offset by them spontaneously increasing their caloric intake or

decreasing their subsequent daily activity during the rest of the day. **Purpose:** The

purpose of this study is to monitor preschooler's PA and caloric intake after planned

PA in the morning. **Methods:** Eight children ages 4-5 were included in this cross over

design study. In a randomized fashion, on one occasion participants were guided

through a thirty-minute structured physical activity session. On the other visit

(control), the children were read a story. On both days daily physical activity levels

were measured with the use of an accelerometer (Polar Active) and caloric intake was

assessed. Repeated measured ANOVA was used with a standard deviation of $p \leq 0.05$.

Results: There was a significant difference reported between conditions in the amount

of time children spent in vigorous+, vigorous, and total active time immediately after

the planned physical activity. No significant differences were found when comparing

end of day activity levels between conditions. No significant differences were found

when comparing post condition and end of day active time between conditions. No

significance was found when comparing calories (kcal) consumed versus calories

(kcal) burned. **Conclusion:** Planned physical activity increases the amount of time

children spend in vigorous+ and vigorous PA time immediately after planned physical

activity. And increases total active time at the end of the day. Planned PA can increase

active time, with no concomitant increase in the food intake to offset energy

expenditure.

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Finally, I would like to dedicate my thesis to my grandparents, Manuel Barbosa, Irondina and Joao Da Silva.

PREFACE

This thesis is written to comply with the University of Rhode Island graduate school Manuscript Thesis Format. This thesis contains one manuscript: *The influence of planned physical activity in preschoolers on subsequent energy balance.*

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MANUSCRIPT

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CHAPTER 1

INTRODUCTION

Research suggests that obesity interventions such as increasing physical activity should start in young children (5). However, it is unknown if the caloric expenditure of planned physical activity in children will be offset by them spontaneously increasing their caloric intake or decreasing their subsequent daily activity during the rest of the day. In order to develop future physical activity interventions for young children, this study aims to investigate if young children can affect their daily energy balance by including a thirty-minute bout of programmed physical activity.

Obesity is a chronic disease and is defined as having excess fat (29). When energy intake exceeds energy expenditure obesity occurs (6). Obesity is a serious concern because it is associated with poor mental health, reduced quality of life, and leads to many health complications (6, 29). There are also many comorbidities associated with obesity such as hyperlipidemia, hypertension, diabetes, coronary arteries disease, stroke, cancer, sleep apnea depression, and infertility (6, 29). Physical inactivity and poor nutrition has been proven to be the prominent cause of obesity and many other life threatening chronic diseases (14). Research has shown that obese parents pass down obesity to their children through genetics and lifestyle choices (27).

Currently, in the US twenty-five percent of children are overweight and eleven percent are obese (6). Research suggests that seventy percent of obese adolescents grow up to become obese adults (6). Many factors, such as, lifestyle, cultural

environment, and environmental factors all take pivotal roles in the rising prevalence of obesity (6). However, many environmental factors that influence obesity are sedentary behavior, which can be altered (5).

Research has suggested that preschoolers should engage in sixty minutes of planned and unplanned physical activity (PA) each day (5). The intensity of these activities should be moderate to vigorous activity (5). According to the CDC, vigorous activity would include running. Moderate activity would include going for a brisk walk (28). On a scale of zero to ten, where sitting is a zero and the highest level of activity is a ten, moderate-intensity activity is a five or six (28). Vigorous activity, on that same scale, would be a seven or higher (28). Despite this, research indicates an increase in sedentary behavior in U.S. preschoolers and suggests many children are not getting the recommended amount (5). Approximately fifty five percent of children between the ages of two and five attend preschool or day care (30). In most countries, preschool attendance represents a substantial amount of children's time, so monitoring preschoolers' sedentary behavior in the preschool setting is relevant (5). Preschool may be an opportunity to increase PA, and there has been minimal research to develop such programs (5,21).

Physical activity helps prevent obesity along with improving psychosocial health, cognitive development, skeletal health, and motor skills (7, 26). However, it's only one part of the energy balance equation. Preschoolers are not able to make the decision of what they eat, that decision comes from their parents (27). Caloric intake at school and at home is important because certain parenting styles could influence obesity (16).

Research has shown that older children and adults make this cognitive decision to be active or sedentary based on the planned physical activity they have already participated in earlier that day. However, there are limited studies exploring the “activitystat” in young children. Therefore, the purpose of this study is to monitor preschooler’s PA and caloric intake after planned PA in the morning. This information could potentially aid in the formation of PA programs in preschools as an obesity intervention strategy.

CHAPTER 2

REVIEW OF LITERATURE

Obesity

Obesity is a chronic disease and it is defined as having excess fat (29). When energy intake exceeds energy expenditure obesity occurs (6). High body fat percentage is an indicator for obesity (3). Women who have a body fat percentage of thirty-two or greater and men who have a body fat percentage of twenty six or greater are considered obese (3). Another way to indicate obesity is using body mass index (BMI). Having a BMI greater than thirty is considered obese (28). BMI can be calculated with the equation $\text{weight (lbs)} \div \text{height (inch)}^2$ (28). Waist circumference is a method to determine your risk of developing obesity (29). By measuring someone's waist circumference, you are measuring their excess fat in the abdominal area (29). Men with a waist circumference greater than forty inches and woman who have a waist circumference greater than thirty-five inches are considered to be at risk for obesity (29).

The root etiology of obesity is difficult to state due to multiple factors that influence it such as genes, environmental factors, lifestyle preferences, diet, medication, behavior, physical inactivity and cultural environment (9,10, 11). A person's lifestyle influences obesity based on the choices they make (9, 10, 11). Weight gain is attributed to physical inactivity and diet; therefore, if a person leads a sedentary lifestyle they aren't expending as many calories as they are consuming (9,

10, 11). Sedentary behavior is characterized as energy expenditure below 1.5 metabolic equivalents while sitting or lying down (27). Sedentary behaviors include watching television, using computers, tablets, smart phones, and playing video games (27). Over time the energy balance will cause excess fat to accumulate and impose many health complications.

Obesity is a serious concern because it is associated with poor mental health, reduced quality of life, and leads to many health complications (6, 29). There are also many comorbidities associated with obesity such as hyperlipidemia, hypertension, diabetes, coronary arteries disease, stroke, cancer, sleep apnea depression, and infertility (6, 29). In 2008 medical care cost for obesity was estimated to be 147 billion dollars. Since then the prevalence of obesity has increased, causing many health and financial problems for millions of Americans (6, 29). Preventative programs are extremely important, especially at a young age to implement healthier lifestyles in order to avoid developing these serious medical conditions.

Obesity and Physical Activity in Adults

Currently, in the US only about twenty-one percent of adults meet the Physical Activity Guidelines (14). According to ACSM recommendations, adults (18-64) should participate in at least 150 minutes of moderate intensity aerobic activity every week along with two days of muscle strengthening exercises (28). Physical inactivity and poor nutrients has been proven to be the prominent cause of obesity and many other life threatening chronic diseases (14). According to the research, a modest and attainable increase in physical activity has a positive effect on a person's health and

the people around them (14). Research has shown that obese parents pass down obesity to their children through genetics and lifestyle choices (27). If a child's parent is physically inactive and has an unhealthy diet, children mimic this lifestyle (27). Their parents make the decision on what they eat and what physical activity they can participate in (27). That is why it's important to explore childhood obesity in children between the ages of four to five years old to prevent them becoming obese adults.

Childhood Obesity

Currently, in the US twenty-five percent of children are overweight and eleven percent are obese (6). The highest rates of childhood obesity have been observed in developed countries (6). Research suggests that seventy percent of obese adolescents grow up to become obese adults (6) Unlike adults; there is no consensus on a cutoff point for excess fatness of overweight in obese children and adolescents.

The Center for Disease Control and Prevention defined overweight as at or above the 95th percentile of BMI for age. The risk for overweight is described as being between the 85th to 95th percentiles of BMI for age (8), see Figure 3 and 4. There are many different ways to measure body composition such as body mass index (BMI), biometrical impedance analysis (BIA), waist circumference, and skin fold measures. Unfortunately, there are reservations about these methods, such as BMI (6). Currently, it is considered the gold standard but it's difficult to accurately state a child's BMI due to their growth (6). A cross sectional study was done and suggested that the BIA is an excellent predictor of body composition in children because it predicts their total body water, fat free mass, and fat mass (3). The BIA accurately

shows the change in body fat over time because it isn't affected by the children's growth (3). Due to its cost and size it's not an appropriate field test making collecting data more difficult (3). According to the World Health Organization (WHO) triceps skin folds are an appropriate way to determine obesity in children (32). Below in figure 1 and 2 is a graph explaining the classification for the triceps skin fold for boys and girls (32).

Physical and psychological health of children are directly linked to overweight and obesity during childhood years (6). Research has shown that there are some cases of childhood obesity are associated with a medical diagnosis such as leptin deficiency, hypothyroidism, growth hormone deficiency, and side effects to certain medications. These prognosis' all cause a chemical imbalance within the body that causes the child to retain excess fat on the body (15). Although there are medical reasons for childhood obesity, lifestyle choices and cultural environment significantly influence obesity. These many factors take pivotal roles in the rising prevalence of obesity (6). However, many environmental factors that influence obesity are sedentary behavior, which is altered (5).

Currently, there isn't a lot of research on programs to prevent obesity. Instead the research has focused on secondary prevention and how to lose weight once they are already obese (6). Adults have a more difficult time losing weight, that is why it would be more practical to implement these preventative interventions with children in schools (6). As you age your body undergoes many changes that cause individuals to gain weight (6). For children it's easier for them to lose weight because they aren't undergoing the same physiological changes as someone in adulthood (6). There are

not many interventions that focus on preventative programs that could curb obesity and ultimately help individuals avoid becoming obese by learning how to live a healthy lifestyle from a young age (6).

Research suggests that physical activity is linked to obesity and have found a link between the physical activity of healthy parents and their children (16). However, not much research has been done to examine the link between physical activity and obesity. McMurray et al examined this relationship by observing the physical activity and sedentary time of obese, low income, ethnic minority parents and their children on weekdays and weekends (16). The data was collected in North Carolina in eight rural sites in the middle and eastern part. One hundred and ninety-nine obese parents and their obese children were subjects in this project. An accelerometer was used three times during the week and once on the weekend. They found a positive relationship, especially on weekends, with parents and their children's physical activity and sedentary behavior patterns (16). Understanding the complexity of this disease is important to create preventative programs for children. Current research has only examined energy output through the use of accelerometers; no research exists that takes into account all factors of daily energy balance, such as caloric intake.

Childhood Obesity and Physical Activity

Research has suggested that preschoolers should engage in 60 minutes of planned and unplanned PA each day (3). According to the CDC only one and three children are physically active everyday (28). Despite this, research indicates an increase in sedentary behavior in U.S. preschoolers suggests many children are not

getting the recommended amount (5). By 2020 it has been predicted that 9.1% of preschoolers are going to be overweight or obese (17, 5). Most studies using objective methods for capturing sedentary behavior levels, such as accelerometers, reported that preschoolers spend between 50% and 80% of their total time sedentary. Numerous studies have shown that sedentary behavior such as watching television and playing video games increase the likelihood of a child becoming obese (24, 25).

Approximately 55% of children between the ages of 2 and 5 attend preschool or day care (30). In most countries, preschool attendance represents a substantial amount of children's time, so monitoring preschoolers' sedentary behavior in the preschool setting is relevant (5). Preschool may be an opportunity to increase PA, and there has been minimal research to develop such programs (5,9). Raustorp et al. compared preschoolers' PA in Swedish and in US settings where he examined differences in boys' and girls' PA in regards to intensity levels and sedentary behavior. Fifty children from Raleigh, NC and Malmo, Sweden, with the average age of four years old, were recorded during preschool time for five consecutive weekdays. The children wore accelerometers to track their activity levels. The accelerometers documented their sedentary, active, and very active times. In conclusion they found that preschoolers in Raleigh, NC spent a significant amount of time indoors compared to preschoolers in Malmö, Sweden who spent most of their time outdoors. Malmo preschoolers spent forty seven percent of their time outdoors being active compared to the US preschoolers who only spent eighteen percent of their time outdoors being active (21).

In the US, children at a preschool age spend 42.1 minutes/hour being sedentary

at school, despite the positive impact it may have on their learning (5). Teachers in Poland and Greece stated that active learning helps children remember things for a longer amount of time and it helps to optimize their focus during other activities (5). Physical activity in children has been positively associated with academic achievement (5). Physical activity generates structural changes in the brain such as neurogenesis, angiogenesis, increased hippocampal volume, and connectivity (5). Research has shown, with the use of accelerometers, that US preschoolers indicated high levels of sedentary behavior during the school day (18,2). Other studies have reported that preschoolers spend a majority of their recess break being sedentary (18,2). Given this information, planned physical activity may be needed in order for preschoolers to reach the recommended sixty minutes of physical activity per day.

Childhood Obesity and Energy Balance

Physical activity helps prevent obesity along with improving psychosocial health, cognitive development, skeletal health, and motor skills (7, 26). However, it's only one part of the energy balance equation. Preschool age (3-5) it is a crucial time in which parents develop communication about food with their children (7, 26). During this crucial developmental stage is when children form distinct eating behaviors. Studies have shown that obesity is related to genetic predispositions, which are food preferences, speed eating, and eating in the absence of hunger (7, 26).

Caloric intake at school and at home is important because certain parenting styles could influence obesity (16). McMurray et al. suggested that the main risk factor for childhood obesity was the unhealthy food choices of their parents (16). More

recently, Skouteris et al. found significant relationships between BMIs of parents and their children. The study concluded that adults influence their child's behavior and lifestyle choices. Further, there is no current research concerning how a planned PA program may affect other parameters of energy balance such as spontaneous PA in children as it does in adults (22).

Despite these developments regarding physical activity government officials still stress the importance of nutrition. In 2012, the Obama administration created the Hunger-Free Kids Act (31). It was put in place to help raise a healthier generation of children by creating new guidelines for school meals (31). The new guidelines state that children in grades preschool through fifth grade are required to have 1/2 cup of fruit, 3/4 cup of vegetables, 1/2 cup of starches, 1 ounce of grains, 1 ounce of meat, and 8 ounces of milk per day (31). Currently, our government is implementing the importance of portion control. No schools have programs put in place to encourage physical activity and energy output.

Across the country we have seen physical education being taken out of schools and recess being shortened or completely eliminated. Research has shown when a child's physical activity time is diminished they become anxious, angry, and lose focus on what is happening in the classroom (12). Physical education and recess have been shown to develop the mind and body. This enhances social and cognitive development, self-esteem, self-confidence, communication skills, and improved academics (12). A physical education (P.E.) teacher, Paul Zientarski, from Napperville, IL developed a program called Learning Readiness P.E (12). It's a program that is designed to help students who are not performing at grade level to still

participate in P.E. They strategically put P.E. before the classes that the students were struggling in and they immediately shown improvement in their reading, math, and science grades (12). Hillman et al explored the effects physical activity has on the brain. They found that by having students participate in physical education, it created synapses in the brain to form, which helped the students learn the material (12). They also found that the students who were once disengaged and acting out in class were more attentive (12).

The activity center has been hypothesized to be in the central nervous system. This controls an individual's amount of physical activity over time, therefore their daily energy expenditure (1). The activity center or "activitystat" would keep total physical activity constant by increasing or decreasing the frequency, intensity, and/or duration of time spent in an intensity level of physical activity or in inactivity (1). For example, on a day that an individual jogs for 30 minutes, they might increase the amount of time spent being sedentary. Whereas on a day that the same individual did not jog, they might increase the amount of time spent walking and decrease the amount of time spent in sedentary activities (1). The "activitystat" hypothesis is opposed to the displacement hypothesis. The displacement hypothesis suggests that watching television and other sedentary behaviors displace physical activity (1). If someone spends more time in an inactive state than in a active state, you will see an inverse relationship between how long a person spends being inactive rather than active (1).

Research suggests that obesity interventions such as increasing physical activity should start in young children (5). However, it is unknown if the caloric expenditure

of planned physical activity in children will be offset by them spontaneously increasing their caloric intake or decreasing their subsequent daily activity during the rest of the day. In other terms, research focuses either on energy out (physical activity) or energy in (caloric intake). In this population you rarely see research comparing both components of energy balance in one study. Research has also been shown that older children and adults make this cognitive decision to be active or sedentary based on the planned physical activity they have already participated in earlier that day (5).

However, there are limited studies exploring the “activitystat” in young children.

Therefore, the purpose of this study is to monitor preschoolers PA and caloric intake after planned PA in the morning. The current research only focuses on spontaneous physical activity and does not take into account planned physical activity and energy balance. This information could potentially aid in the formation of PA programs in preschools as an obesity intervention strategy.

CHAPTER 3

METHODOLOGY

Study Design

After approval from the University of Rhode Island's Institution Review Board, preschool children from Dr. Day Care in Smithfield, RI were recruited to participate in this cross-over design study. The influence of planned physical activity in preschoolers on subsequent energy balance was examined. The participants read and signed the informed consent form (Appendix A) prior to the start of the study.

Participants

Fifty subjects were notified of the study and eighteen subjects agreed to participate. The subjects were then divided randomly and equally into 2 groups. Group one participated in story time first and Group two participated in physical activity first. Nine subjects dropped due to absences and not wanting to wear the watch. Nine preschool children, both male and female (4-5 years old) were included in this study, see Table 1. There were six male and three female subjects. Subjects were randomized with an n=18. Other than age, the only inclusion criteria was their ability to perform age-appropriate physical activity such as jumping, marching, and walking. Children who were unable to complete these tasks due to musculoskeletal issues or other health concerns (such as asthma) were excluded.

Parental Instructions, Responsibilities, and Questionnaires

After the parents provided consent, they were asked to fill out a modified version of the Harvard School of Public Health Physical Activity for Preschoolers

questionnaires (Appendix B). Parents were instructed on how to place the Polar Active on their child's wrist and we asked them to take pictures of the foods and drinks their child ate at home on the two intervention days. Parents were also asked a few follow up questions to assess if they felt their child followed their normal dietary and activity routine.

Anthropometrics

Height was measured in centimeters using a Seca 216 stadiometer (Hanover, MD). The measurement was taken from the floor to the top of their head, while their feet was together on the floor. Weight was measured in kilograms with a calibrated Tanita scale (Tanita Corporation, Japan). The children were weighed on the center of the scale and shoes were removed. These measures were taken for future research.

Physical Activity Measures

Physical activity was measured with a Polar Active accelerometer (Polar, Lake Success, NY). The Polar Active device resembles a watch that the children wore on their wrist. Parents were asked to place the watch on their children's wrist when they woke up the morning of the intervention and they took it off when they went to bed at night. The Polar Active measured how many steps the child took, extrapolate calories expended, and how much time the children spent in vigorous+, vigorous, moderate, easy, and very easy active time, and total active time (vigorous+, vigorous, moderate time combined).

Caloric Intake Measures

In order to assess energy intake, parents were asked to take a before and after picture of any food their child ate at home on the intervention days and text or email it

to the investigators. Parents were encouraged to maintain their normal familial dietary habits on these days and not sway their child from their normal eating habits. When the children were at day care, investigators logged any food and drink the children ate. Dietary intake will be analyzed using ASA 24 for calories and nutrient value.

Intervention

Planned Physical Activity

On the first visit to the children's day care, the investigators guided the children through a thirty-minute series of age appropriate physical activity games such as Blast Off, Messy Back Yard, and mimicking animal moves. This type of programming has been previously described in the literature (20). Pulse rate was taken pre, mid, and post physical activity with a Smart Heart Pulse Monitor (Learning Resources, Vernon Hills, IL), which is a heart shaped device that children held over their own hearts to hear their heart beats. Investigators allowed the children to familiarize themselves with this device prior to the physical activity. This device allowed for an accurate heart rate reading and was tolerated better by the children compared to taking a manual pulse or using a standard heart rate monitor. The device worked in a similar fashion as an automatic stethoscope, but is less intimidating and was more fun to use with kids.

Story Time

On the other visit, investigators asked the children to sit and listen to them read two stories each lasting ten minutes. Like the physical activity day, pulse rate was taken with the same Smart Heart Pulse Monitor pre, mid, and post reading time. This day acted as a control day to ensure that any increased physical activity during and

after the investigation visits was not due to the excitement of having a new person in their room. These visits were randomized to account for any order effect and took place one day apart from each other.

Statistical Analysis

A repeated measures ANOVA was used to analyze the data. In the case of a significant F score, a Bonferroni Post Hoc test was performed to determine where significant differences lay. Significance was set at $p \leq 0.05$. Data tested for normality with skewness and kurtosis.

CHAPTER 4

FINDINGS

Demographics

Subject characteristics are present in Table 1.

Performance Results

When comparing activity level between conditions a significant difference was seen in the amount of time children spent in vigorous+ and vigorous time, as shown in Table 4. When comparing end of day active time between conditions a significant difference was seen, as shown in Table 5. No significant differences were found when comparing end of day activity levels between conditions, as shown in Table 2. No significant differences were found when comparing post condition and end of day active time between conditions, as shown in Table 3. No significant differences were seen when comparing total calories (kcal) burned versus total calories (kcal) consumed, as shown in Table 6.

CHAPTER 5

CONCLUSION

The results of this study indicated that planned physical activity (PA) does have a positive effect on the amount of time the subjects spent in vigorous+ and vigorous PA time immediately after planned physical activity. Planned physical activity also had a positive effect on the subjects' active time (vigorous+, vigorous, moderate PA). When comparing individual activity levels (vigorous+, vigorous, moderate, easy, very easy PA) at the end of the day between conditions, planned PA did not have an effect overall on activity levels. When comparing the activity level (vigorous+, vigorous, moderate, easy, very easy PA) from immediately after the condition to the end of day, there was no effect on the subject's activity level. No significant differences were seen when comparing total calories (kcal) burned versus total calories consumed.

To our knowledge, this is the first study to measure the effects planned physical activity has on preschoolers' (4-5 years old) subsequent energy balance. After statistically analyzing total activity level we found that the subjects were not anymore active after the planned physical activity then the day we read them a story. However, when statistically analyzing their active time (vigorous+, vigorous, moderate) individually, the subjects were more active after the planned physical activity then when they were read a story, as shown in Figure 4. The subjects also spent more time being vigorously active immediately after the planned physical activity then when they were read a story, as shown in Figure 3. Other research has found success in

increasing vigorous and moderate PA through structured recesses (13). Huberty et al. examined PA levels at recess with the use of Actigraph accelerometers and heart rate monitors (13). They had specific planned activity zones, trained staff, and playground equipment. Ninety-three students from public elementary school in the Midwest participated in this study. The accelerometers were administered at 7:30AM and taken off at 4:30PM. Based on the age groups, the activity zones had difference types of physical activity for the children to participate in. They had the choice to switch groups whenever they wanted to during recess. Everyday the activity zones were redesigned by trained physical education teachers. Investigators reported a significant increase in vigorous and moderate PA on the days that the children participated in the structured recess when compared to the days the children participated in unstructured recesses (13).

Research has suggested that preschoolers should engage in 60 minutes of planned and unplanned PA each day (5). Despite this, research indicates an increase in sedentary behavior in U.S. preschoolers suggesting many children are not getting the recommended amount (5). Based on the data obtained from the current study and Huberty et al., planned physical activity does increase the amount of vigorous+ and vigorous PA the children participate in.

The current study reported no increase in total activity time (vigorous+, vigorous, moderate, easy, very easy PA) after a planned physical activity, as shown in Figure 5. The results of the current study suggests that planned physical activity had no affect on the total activity time between immediately post the condition to the end of day, as shown in Figure 6. Unexpectedly, we saw an increase in total active time

(vigorous+, vigorous, moderate PA) but no significant difference in total activity levels (vigorous+, vigorous, moderate, easy, very easy) when compared to the standard deviation. Although we didn't find significance it is still important because the subjects didn't spend more time being sedentary but did spend more time in vigorous +, vigorous, and moderate time.

Total activity levels (vigorous+, vigorous, moderate, easy, very easy) were reported as being insignificant and this could be due to a number of reasons that affected their choice. Such as the day care doesn't implement a planned physical activity, they only have recess once a day in the afternoon. The current study did a planned physical activity session in the morning, which could have disrupted the subjects' schedule. By having the sessions in the morning it could have exhausted them for the rest of the day especially if they are not accustomed to having planned physical activity session. The subjects could have been making this conscience decision to be less active since they were active in the morning. According to the recent literature, it's hypothesized that individuals contain an activity center or "activitystat" in their central nervous system. The "activitystat" would keep total physical activity constant by increasing or decreasing the frequency, intensity, and/or duration of time spent in an intensity level of physical activity or in inactivity (1). In future research, this could be something that is investigated to see what drives children's decision to be active or not.

The subjects also cannot make decisions on their own so parental influence could have also effected their total activity time. Some of the subjects may not have the opportunity to be spontaneously active based on their living situation. If some of

the subjects don't have safe neighbors or yards their parents may have them watching television or play video games rather than playing outside (4). Currently, the US children are more sedentary now then ever before because of the technology (4). Implementing planned physical activity in schools is important to help get children more active and healthy. In addition, they may not have full control over nutritional decisions and their caloric intake.

In the current study, planned physical activity had no effect on total amount calories consumed versus total calories burned, as seen in Figure 7. Although there wasn't a significant difference, the subjects reported consuming more calories (kcal) at school than at home. There were some limitations that could have affected the dietary intake of the subjects. During breakfast, lunch, and snack at the day care the subjects were not allowed to ask for seconds due to the USDA guidelines on portion/nutrition. This could have affected the amount of calories consumed at school to be insignificant.

The current study suggests that, although some of our results support the "activitystat" theory, it primarily supports the displacement theory. When comparing the end of day results the subjects weren't anymore active or less activity on the intervention days. This suggests that the "activitystat" did not influence their decision to be more active or less active after a planned physical activity. The subjects also didn't choose to eat anymore or any less on the intervention days. However, planned physical activity did increase the amount of time the children spent being vigorous+, vigorous, and moderately active. This suggests that when planned physical activity is

implemented into their day it increase the total amount of time the children are being active.

Limitations

There were some limitations to this study such as some of the subjects participated in extracurricular activities such as soccer, basketball, football, dance, etc. This may have affected the amount of time they spent in vigorous+ and vigorous PA time on one of the condition days causing the results to be insignificant when comparing total activity. On the planned physical activity day, one child became ill after the intervention and was laying down most of the day until their parent picked them up. Due to their sedentary behavior, after the planned PA, it could have affected the results for total activity. Also, the low sample size in the current study may have led to larger standard deviations, thus affecting the statistical analysis. In future research, the sample size should be increased to account for any other activities the subjects may participate in outside of school. Although most of the children were compliant when wearing the polar accelerometer watches, some children did not like wearing them. This caused for an increase in the drop out rate resulting in the current investigation to have an n=9.

Parents were responsible for sending the investigators pictures of their child's dinner before and after along with a description of what ingredients were used. The investigators received detailed pictures of the children's dinners and were able to ask follow up questions to many of the parents. While investigators were at the day care all of the subjects portions were measured before and after the meal allowing for the data to be as accurate as possible.

Due to the busy schedules families have some of the self-report of what their children ate was poor. They sent the investigators photos of the child's meal before and after but some did not give a detailed description of the ingredients. They also may have not measured the portions; therefore they may have under reported the amount of food their child ate. This could account for a low amount of calories consumed at home. In contrast, the subjects did consume two meals and a snack when compared to the one meal that they consumed at home. They spent more time eating at school because most of their time was spent there, which could account for the increase in calories.

In contrast, there are many strengths to the study. First, the subjects were randomized into groups. Participants ate breakfast, lunch, and snack at the same time everyday and followed the USDA guidelines for portion/nutrition control assuring that each subject was receiving the same amount of food each time. The activities that the subjects participated in were all age appropriate and designed to keep subjects active for thirty minutes. The planned physical activity and story time were both thirty minutes and administered at the same time for each group.

In conclusion, planned physical activity did have a positive effect on the amount of time children spend in vigorous+ and vigorous PA time. Along with positively affecting the total amount of time children spend being active (vigorous+, vigorous, and moderate PA). Even though the current study did not find significance in the children's total activity level (vigorous+, vigorous, moderate, easy, very easy) after planned physical activity it is still important to stress the need for planned physical activity in the education system. Obesity is the number 2 leading cause of

preventable deaths and implementing a healthy lifestyle at a young age will help decrease the obesity epidemic (29).

Practical Applications

This investigation could potentially aid in the formation of PA programs in preschools as an obesity intervention strategy. Research has shown that obese children become obese adults (5). In order to fight this, a change in PA in schools must happen. The current study could also aid in stressing the importance of physical education in the school system. Physical activity is important for not only physiological reasons but also for cognitive and social development (3).

TABLES

Table 1: Subject Demographics

Demographics of male and female participants (n=9). The mean (\pm SD) of age, height, and weight. CM=centimeters, kg=kilograms.

| Mean \pm SD | |
|----------------|-------------------|
| Age (years) | 4.111 \pm 0.33 |
| Height (cm) | 106.32 \pm 4.66 |
| Weight (kg) | 17.84 \pm 1.52 |
| BMI | 15.68 \pm 1.16 |
| BMI Percentile | 53.66 \pm 27.56 |

Table 2: Total Activity Level Test result means (\pm SD)

Activity level measured (Mean \pm SD) at the end of the day (24hrs) for each condition. Testing was performed on each condition every other day for 4 days total. There were no significant differences between conditions ($p \leq 0.05$ n=9.) Min=minutes

| | Physical Activity | Story Time |
|-------------------------|---------------------|--------------------|
| Vigorous + (min) | 9.44 \pm 5.91 | 15.22 \pm 22.03 |
| Vigorous (min) | 21.55 \pm 9.12 | 26.11 \pm 19.94 |
| Moderate (min) | 49.88 \pm 18.89 | 53.33 \pm 16.61 |
| Easy (min) | 83.22 \pm 23.54 | 68.44 \pm 28.21 |
| Very Easy (min) | 530.22 \pm 158.67 | 509.11 \pm 95.81 |

Table 3: Activity levels immediately post the condition to end of day result means (\pm SD)

Activity levels measured (Mean \pm SD) between immediately post the condition and to end of day (24hrs). Testing was performed on each condition every other day for 4 days total. There were no significant differences between conditions, ($p \leq 0.05$ n=9.)
Min=minutes.

| | Physical Activity | Story Time |
|-------------------------|---------------------|---------------------|
| Vigorous + (min) | 5.66 \pm 3.50 | 15.11 \pm 22.06 |
| Vigorous (min) | 15.44 \pm 9.15 | 25.66 \pm 20.18 |
| Moderate (min) | 41.55 \pm 16.97 | 49.22 \pm 20.38 |
| Easy (min) | 71.66 \pm 18.43 | 56.77 \pm 28.21 |
| Very Easy (min) | 431.11 \pm 149.02 | 412.66 \pm 114.01 |

Table 4: Test result means (\pm SD)

Vigorous+ and vigorous activity levels measured (Mean \pm SD) immediately after the conditions. Testing was performed on each condition every other day for 4 days total. There were significant differences between conditions ($p \leq 0.05$ n=9.) Min=minutes, *=significance.

| | Physical Activity | Story Time |
|-------------------------|-------------------|------------------|
| Vigorous + (min) | 3.77 \pm 2.78* | 0.11 \pm 0.33* |
| Vigorous (min) | 6.11 \pm 2.47* | 0.44 \pm 0.33* |

Table 5: Test result means (\pm SD)

Total active time (vigorous+, vigorous, moderate) was measured (Mean \pm SD) at the end of the day (24hrs). Testing was performed on each condition every other day for 4 days total. There were significant differences between conditions ($p \leq 0.05$ n=9.)

Min=minutes, hrs=hours, *=significance.

| | Physical Activity | Story Time |
|-------------------|--------------------|--------------------|
| Active Time (min) | 80.88 \pm 31.08* | 71.33 \pm 30.37* |

Table 6: Test results means (\pm SD)

Total calories (kcal) burned versus total calories (kcal) consumed. Testing was performed on each condition every other day for 4 days total. There were no significant difference between conditions ($p \leq 0.05$ $n=7$.) kcal=calories

| | Physical Activity | Story Time |
|---|----------------------|---------------------|
| Calories (kcal) Burned | 1117.14 \pm 100.28 | 1050.71 \pm 98.41 |
| Total Calories (kcal) Consumed | 957.57 \pm 324.25 | 955.14 \pm 345.65 |

Table 7: Test results means (\pm SD)

Total calories (kcal) consumed at home versus at school. Testing was performed on each condition every other day for 4 days total. There were no significant difference between conditions ($p \leq 0.05$ $n=7$.) kcal=calories

| | Physical Activity | Story Time |
|---|-------------------|------------------|
| Total Calories (kcal) Consumed at Home | 360.57 \pm 140 | 349.57 \pm 222 |
| Total Calories (kcal) Consumed at School | 597 \pm 215 | 605.57 \pm 142 |
| Total Calories (kcal) Offered at school | 836 \pm 318.19 | 755 \pm 116.67 |

FIGURES

Figure 1: Triceps skinfold-for-age Girls (3 months to 5 years old)

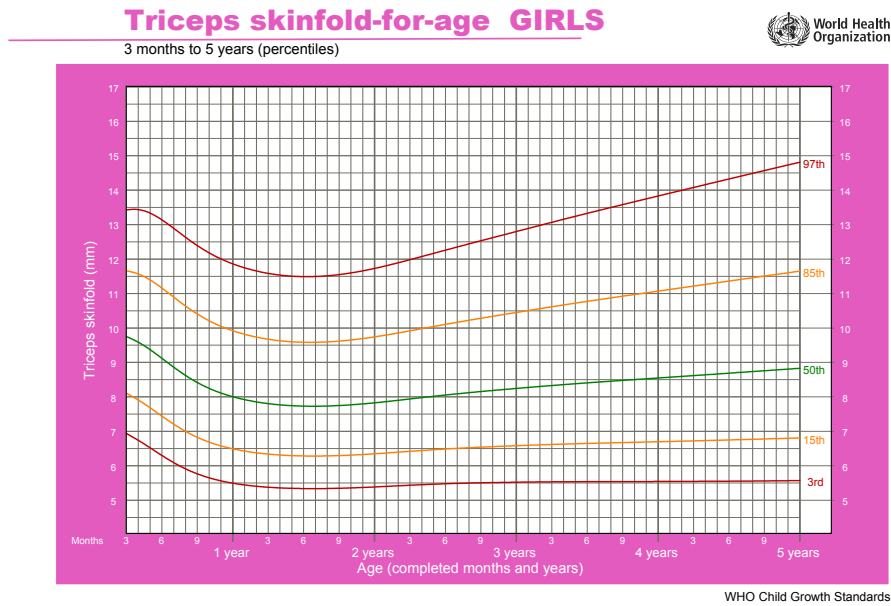


Figure 2: Triceps skinfold-for-age Boys (3months-5 years old)

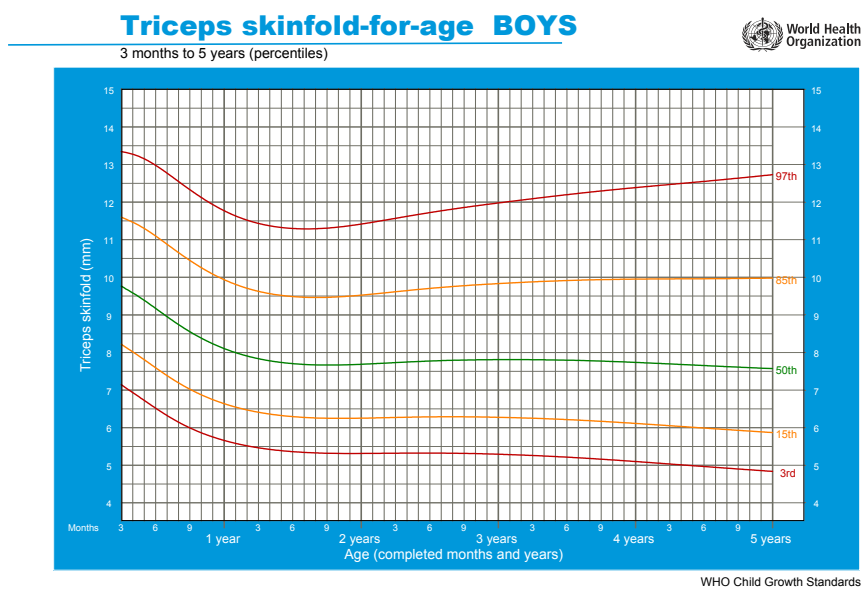
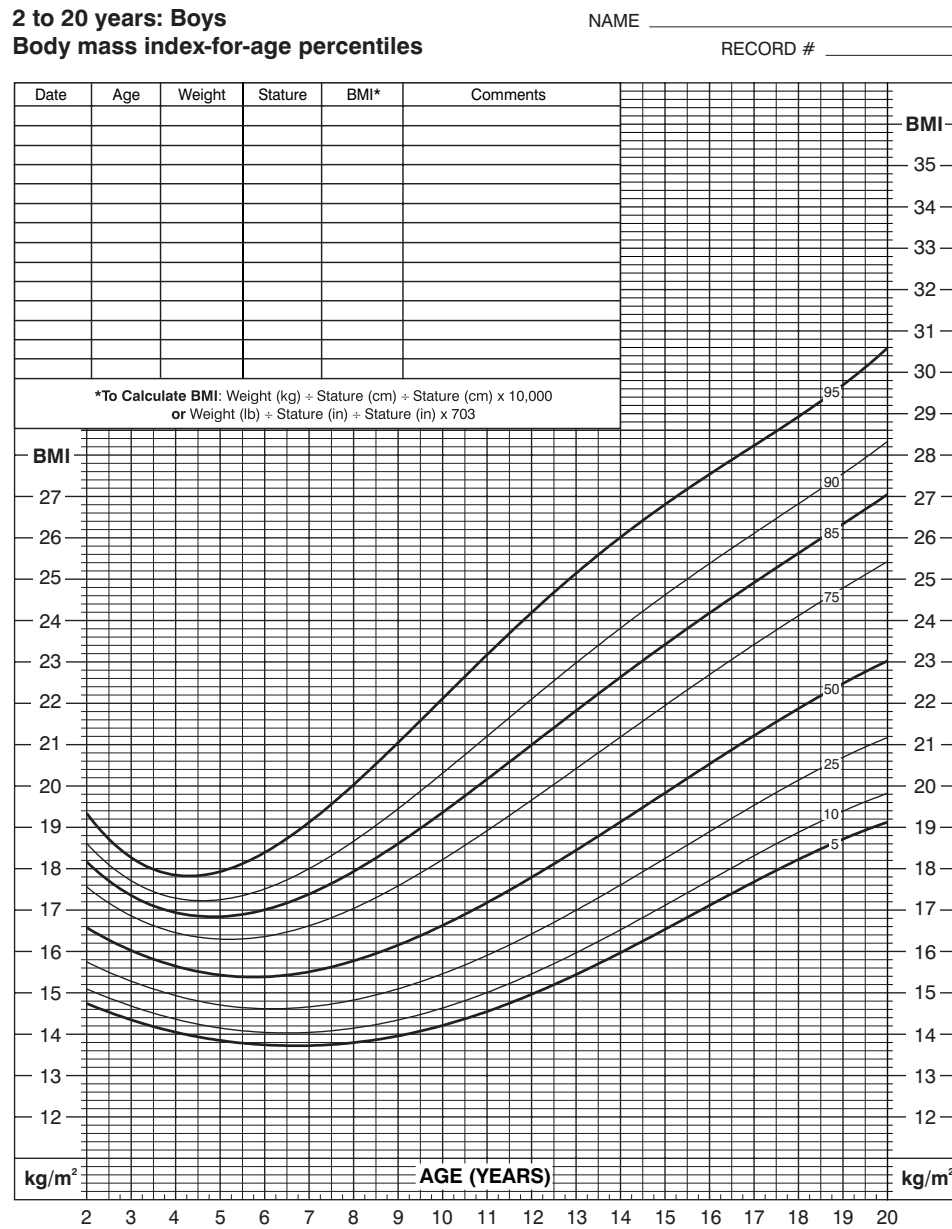


Figure 3: Center for Disease control's guidelines for body mass index for boys, ages 2-20 years old, percentiles.



Published May 30, 2000 (modified 10/16/00).
SOURCE: Developed by the National Center for Health Statistics in collaboration with
the National Center for Chronic Disease Prevention and Health Promotion (2000).
<http://www.cdc.gov/growthcharts>



2-20 years old, percentiles.

[illegible]

Published May 30, 2000 (modified 10/16/00).
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).
<http://www.cdc.gov/growthcharts>



Figure 5: Vigorous+ and Vigorous Time

Vigorous+ and vigorous activity levels measured (Mean \pm SD) immediately after the conditions. Testing was performed on each condition every other day for 4 days total. There were significant differences between conditions ($p \leq 0.05$ $n=9$.) *= significance
Min=minutes.

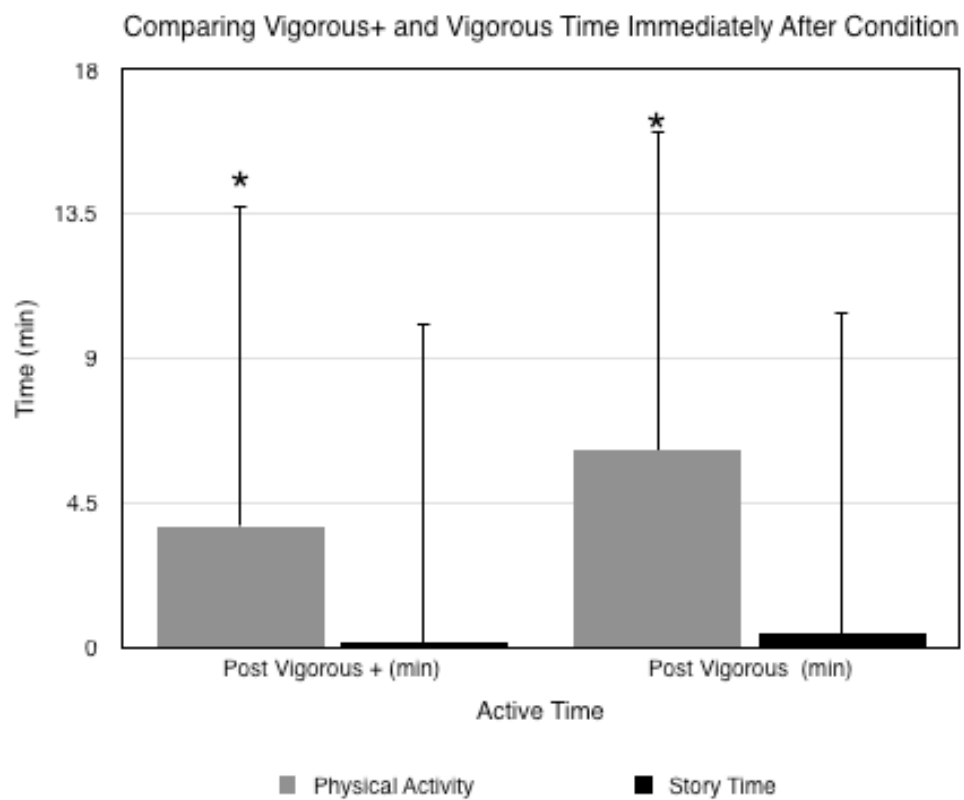


Figure 6: Total active between conditions

Total active time (vigorous+, vigorous, moderate) was measured (Mean \pm SD) at the end of the day (24hrs). Testing was performed on each condition every other day for 4 days total. There were significant differences between conditions ($p \leq 0.05$ n=9.)

*= significance, Min=minutes.

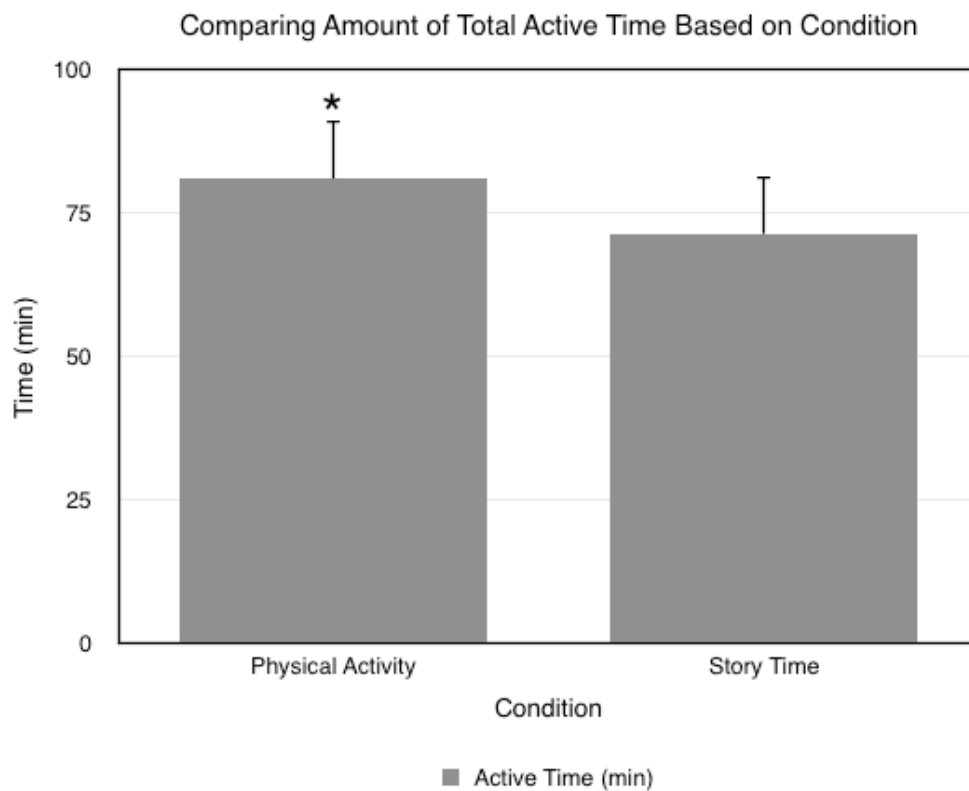


Figure 7: Total Activity Levels Based on Conditions

Activity levels measured (Mean \pm SD) between after the condition and the end of day (24hrs). Testing was performed on each condition every other day for 4 days total.

There weren't any significant differences between conditions ($p \leq 0.05$ $n=9$.)

Min=minutes.

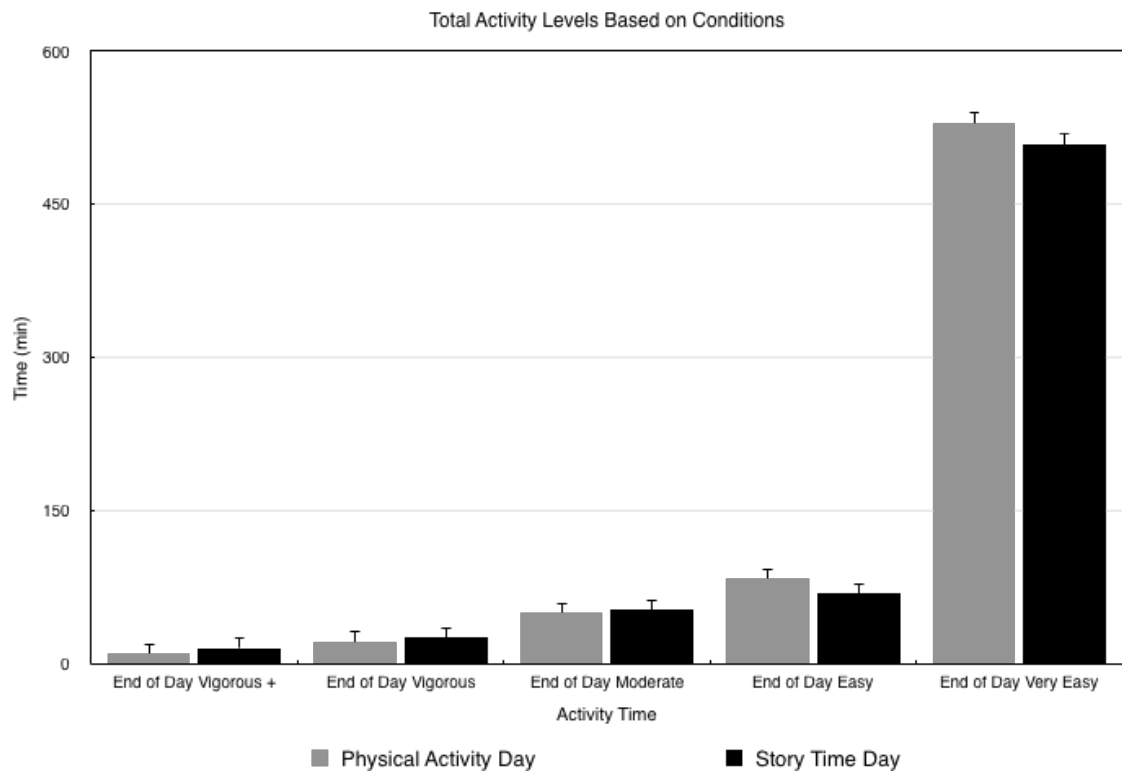


Figure 8: Comparing activity levels post conditions to end of day

Activity levels measured (Mean \pm SD) between after the condition and the end of day (24hrs). Testing was performed on each condition every other day for 4 days total.

There weren't any significant differences between conditions ($p \leq 0.05$ $n=9$.)

Min=minutes.

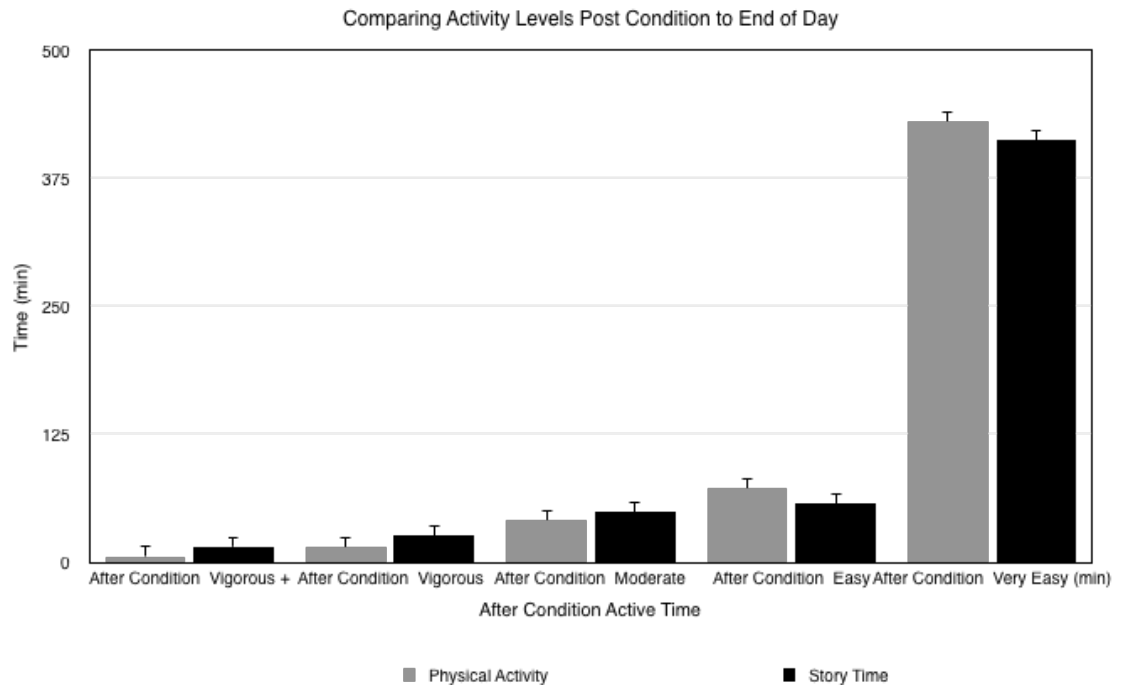


Figure 9: Total calories burned versus calories consumed

Total calories burned versus total calories consumed measured (Mean \pm SD) Testing was performed on each condition every other day for 4 days total. There weren't any significant differences between conditions ($p \leq 0.05$ $n=7$.) Kcals=calories.

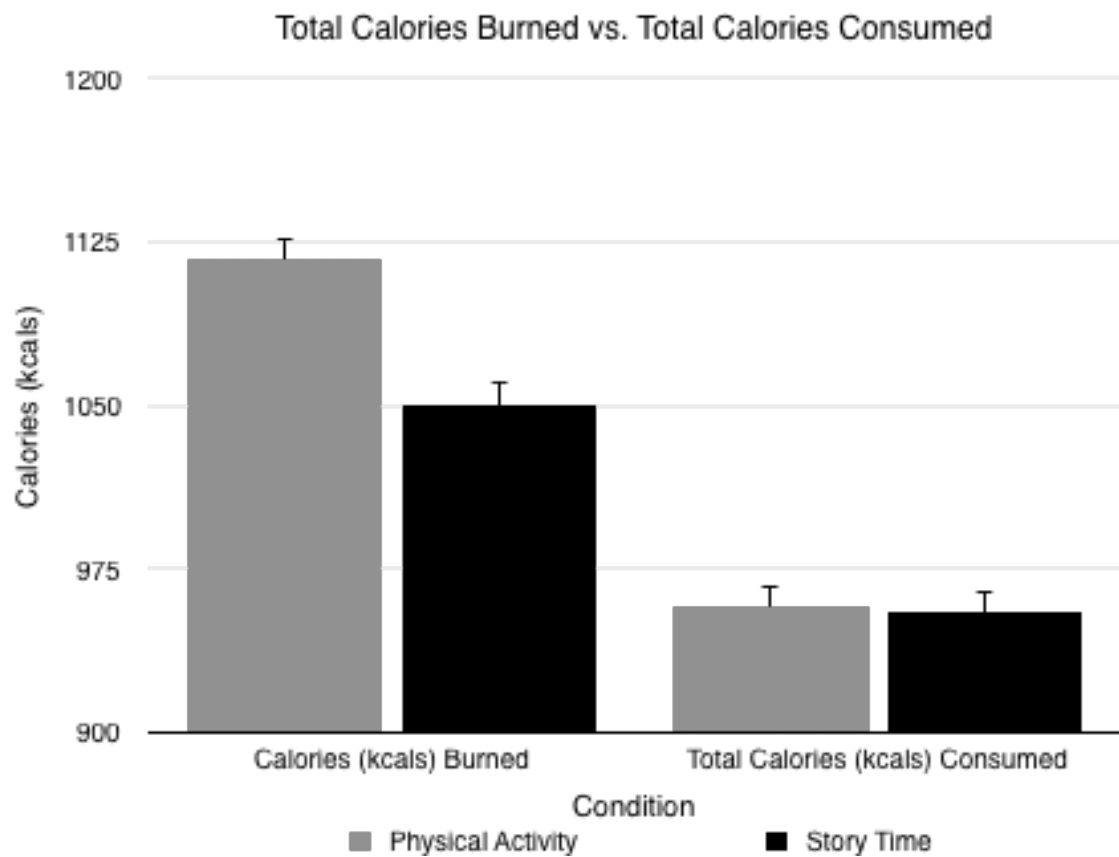
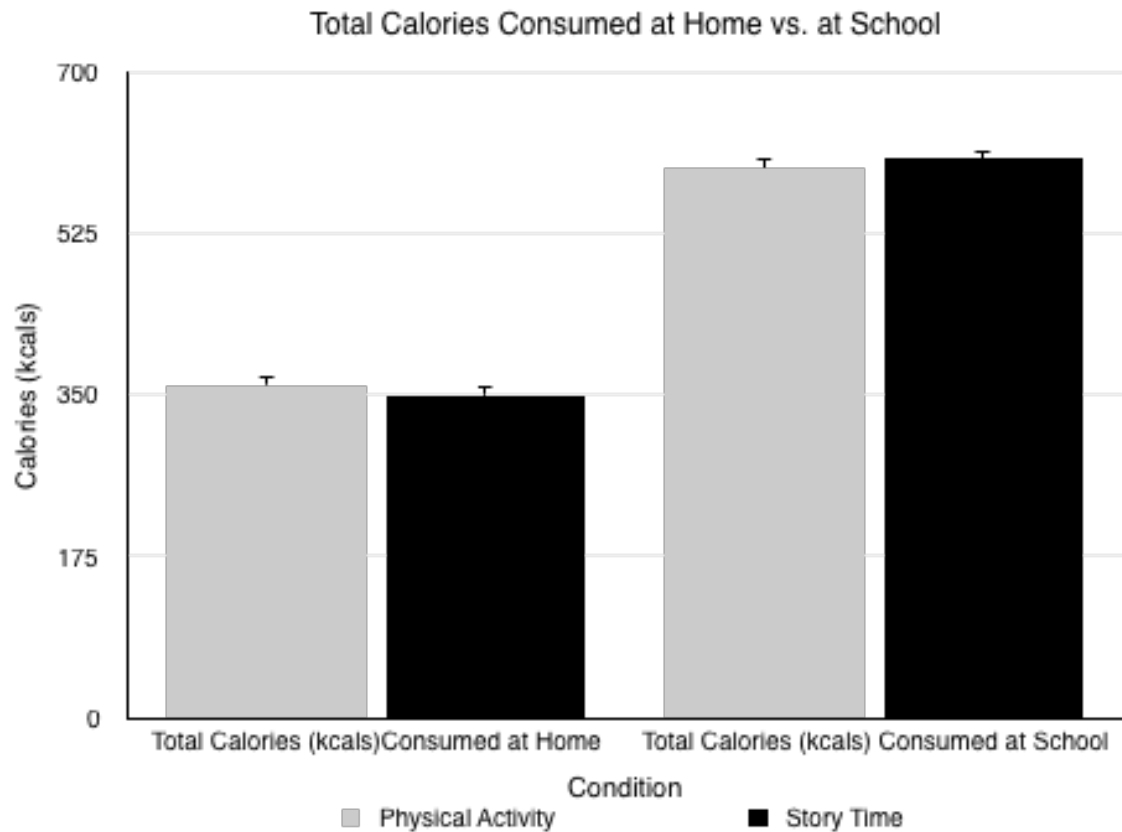


Figure 10: Total calories consumed at home vs. at school

Total calories consumed at home vs. at school (Mean \pm SD). Testing was performed on each condition every other day for 4 days total. There weren't any significant differences between conditions ($p \leq 0.05$ n=7.) Kcals=calories.



APPENDICES

Appendix A

Parental Consent Form for Research

THE
UNIVERSITY
OF RHODE ISLAND
COLLEGE OF
HUMAN SCIENCE
AND SERVICES

Department of Kinesiology
25 West Independence Way, Kingston, RI 02881 USA p: 401.874.2976 f: 401.874.4215



Parent/Guardian Permission Form

Dear Parent or Guardian,

Description of the Project:

Your child is invited to participate in a research study. My name is Disa Hatfield and I am a faculty member in the Kinesiology Department at the University of Rhode Island (phone 401-874-5183.) I am conducting a research study on the effects of physical activity on children. The research study is called “The influence of planned physical activity in three-year-olds on spontaneous energy expenditure and caloric intake.” The purpose of this study is to learn about the effects of planned physical activity on activity levels and hunger for the rest of the day. The study will take place at your child’s day care center.

What will be done:

Throughout the program, your child will be asked to wear an activity monitor called Polar Active, partake in a planned session physical activity, and have their height and weight measured. We will also log the type and amount of food your child eats while at day care and we will ask you to take a before and after picture of any food and meals your child eats at home on the two study days.

The study will take place on two different days, one week apart. On one day, members of our research team will come to your child’s classroom and play 30 minutes of physical activity games with the class. The games are normal preschool activities such as dancing, hopping around, and running. Before, at the midpoint, and after this time we will listen to your child’s heartbeat to assess heart rate. On the second study day, instead of playing games, we will read some books to the class.

Polar Actives are devices that measure how many steps a person has taken, physical activity and calories expended. Your child will wear it on their wrist just like a watch. The accelerometers will be worn on the two days of the study. After each day of the study, we will be at the day care to collect the Polar Actives. This is a picture of the monitor:



Your responsibilities:

While your child is at home on the two days of the study, we will ask you to write down or take a picture with your phone of all the food and drink your child eats. For instance, at dinner, simply take a picture of your child’s plate before and after eating and text or email the picture to us or we will provide a log that you can write down type and amount of food your child ate.

We will ask you to put the monitor on your child when he or she wakes up in the morning and take it off at bedtime. We will have the Polar Actives for you to pick up at the day care the day before each study day. You will also be asked to complete a short questionnaire and an interview on how active and healthy you think your child is. These questions will take about 15 minutes.

Your child's participation in this study is voluntary. If you choose not to allow your child to participate, or if your child does not choose to participate, it does not affect your child's enrollment in daycare at all. If you or your child chooses not to participate they will simply visit another classroom for the 30 minutes of time we will be doing the physical activity and reading session. You or your child may withdraw from participation at any time.

Confidentiality:

The results of the research study may be published, but your child's name will not be used in any way. All results and data will be confidential. Every child's information will be assigned a code number so that individual identities will be known only to the researcher and any coded information stored on Disa's computer will be password protected. All identified data will be destroyed at the end of the study. Data collected and consent forms will be stored securely in a locked file cabinet in Dr. Disa Hatfield's office in Independence Square II for three years after the completion of the study.

Risks or discomfort:

The possible risks and discomforts of the study are minimal and similar to the risks of normal play and recreation.

Benefits of this study:

There are numerous possible benefits of your child's participation in the research. The mental/emotional benefits include learning some new physical activity games. The potential social benefits include interaction with other children in the study. In addition, information on your child health will be shared with you and your child. It is believed that children who enjoy and participate in physical activities will be more likely to maintain a healthy lifestyle.

Rights and Complaints:

If you are not satisfied with the way this study is performed, you may discuss your complaints with Disa Hatfield, anonymously, if you choose. In addition, if you have questions about your child's rights as a research participant, you may contact the office of the Vice President for Research, 70 Lower College Road, Suite 2, University of Rhode Island, Kingston, Rhode Island, telephone: (401) 874-4328.

If you have any questions about your child's rights as a research participant you may contact me at doch@uri.edu or (401) 874-5183.

Thank you very much for your time and consideration in this matter,
Disa Hatfield Ph.D.

- ☐ I do
☐ do not

give consent for my child, _____ to participate in the study described above, to be conducted by Dr. Disa Hatfield. I understand that my child may withdraw from the study at any time with no penalty. I understand that my child's identity will be kept confidential at all times.

Signature of Participant

Signature of Researcher

Typed/printed Name

Typed/printed name

Date

Date

Appendix B

Harvard School of Public Health Physical Activity for Preschoolers

questionnaires

Section 1. Socio-Cultural Influences on Physical Activity

This part of the survey interview asks for your views about to what extent your social and cultural background influence your child's daily physical activity habits. When answering the following questions, please think about to what extent you agree or disagree with the following statements. For the next questions there are also five possible categories of answers: strongly disagree, somewhat disagree, somewhat agree, strongly agree, and don't know. Please circle the answer most appropriate. If you are unsure about how to answer a question, please give the best answer you can.

1. A physically active child is a healthy child.

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

2. I feel it is important for me to participate in physical activities and exercises with my child (such as dancing, running around).

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

3. I worry my child does not get enough physical activity.

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

4. A child needs to increase his/her levels of physical activity and exercise to prevent other related health problems (such as high cholesterol, high blood pressure, diabetes).

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

5. A child needs to increase his/her levels of physical activity and exercise to prevent obesity.

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

Section 2. Socio-Cultural Influences on Sedentary Behaviors

This part of the interview asks for your views about to what extent your social and cultural background influence your child's daily sedentary behaviors. When answering the following questions, please think about to what extent you agree or disagree with the following statements. For the next questions there are also five possible categories of answers: strongly disagree, somewhat disagree, somewhat agree, strongly agree, and don't know. Please circle the answer most appropriate. If you are unsure about how to answer a question, please give the best answer you can.

1. During the week, I limit the amount of time my child watches TV or videos.

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

2. During the weekend, I limit the amount of time my child watches TV or videos.

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

3. During the week, I limit the amount of time my child plays video games (like Game boy, Sega, play station) or is on the computer.

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

4. During the weekend, I limit the amount of time my child plays video games (like Game boy, Sega, play station) or is on the computer.

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

5. I offer TV, videos, or video games to my child as a reward for good behavior.

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

6. I allow my child to watch television when I am too busy to play with him/her.

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

7. I believe that television helps my child improve her/his English.

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

8. I believe that it is important for a child to rest and not be physically active all the time in order to be healthy.

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

9. My child needs to decrease his/her sedentary behaviors (such as watching TV, playing video games, playing on computer) so he/she doesn't develop obesity and other health problems.

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

Section 3. Environmental Influences on Physical Activity

In this next part of the interview I am going to ask you about how the physical environment, such as the availability of parks in your neighborhood, safety, etc. influences your preschool child's physical activity habits. When answering the following questions, please think about to what extent you agree or disagree with the following statements. If you are unsure about how to answer a question, please give the best answer you can.

1. My neighborhood is not safe enough for me to allow my child to be outdoors a lot.

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

2. My neighborhood does not have enough places for my child to play (such as parks, YMCA).

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

3. The cost of participating in physical activities (such as buying sports equipment and membership to gyms, enrolling in sports) is too high, limiting my child's participation.

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

Strongly disagree Somewhat disagree Somewhat agree Strongly Agree Don't know

In this part of the interview I am going to ask you for your views on how organizations such as day care influence your child's physical activity and sedentary behaviors. When answering the following questions, please think about to what extent you agree or disagree with the following statements. There are five possible categories of answers: strongly disagree, somewhat disagree, somewhat agree, strongly agree, and don't know. If you are unsure about how to answer a question, please give the best answer you can.

Not at all Somewhat Yes Unsure N/A

Not at all Somewhat Yes Unsure N/A

I am now going to ask you some more general questions about your preschool child.

Has your child ever had an attack of wheezing that has caused him/her to be short of breath?

Yes No

Yes No

| Yes | | No | |
|-----|---|----|---|
| 1 | 2 | 3 | 4 |

Appendix C



Would you like your child to participate in a research study about physical activity?

Researchers from URI want to see the effects of physical activity in preschoolers. The researchers, Dr. Disa Hatfield and Dr. Emily Clapham, want to visit our classroom and do 30 minutes of exercise games with the children and observe the effects of the exercise. If you let your child participate, this is what they will ask you and your child to do:

- Have your child wear a special wrist watch that will record their physical activity on two separate days
- Take pictures of what your child eats on the same days they wear the watch with your cell phone and text or email the pictures
- Let your child participate in the physical activity session led by Emily and Disa on one day and let them listen to a story told by the same people on another day
- Let Emily and Disa write down what your child ate for lunch and snack while at day care
- Answer some questions about your child's activity levels at home

Disa and Emily will be available for questions during child pick-up times next week and to invite your child to participate in the study.



Would you like your child to participate in a research study about physical activity?

Researchers from URI want to see the effects of physical activity in preschoolers. The researchers, Dr. Disa Hatfield and Dr. Emily Clapham, want to visit our classroom and do 30 minutes of exercise games with the children and observe the effects of the exercise. If you let your child participate, this is what they will ask you and your child to do:

- Have your child wear a special wrist watch that will record their physical activity on two separate days
- Take pictures of what your child eats on the same days they wear the watch with your cell phone and text or email the pictures
- Let your child participate in the physical activity session led by Emily and Disa on one day and let them listen to a story told by the same people on another day
- Let Emily and Disa write down what your child ate for lunch and snack while at day care
- Answer some questions about your child's activity levels at home

Disa and Emily will be available for questions during child pick-up times next week and to invite your child to participate in the study.

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